Eternal Flight as the Solution for 'x'

Completed Technology Project (2013 - 2014)

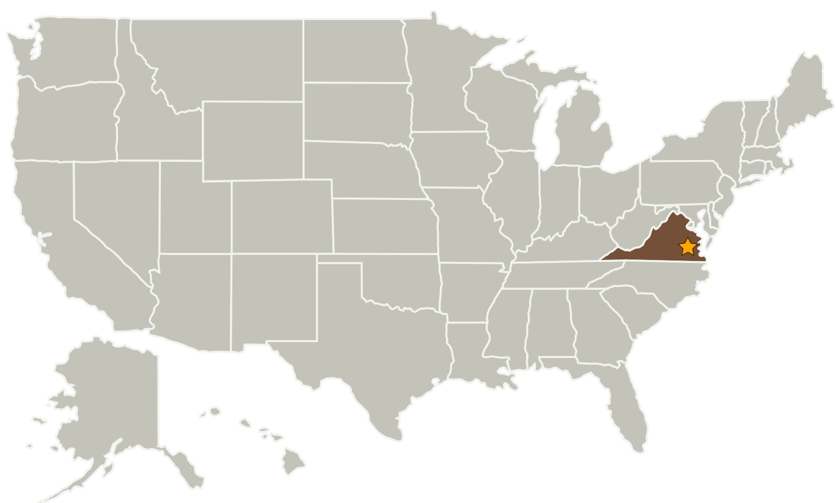
Project Introduction

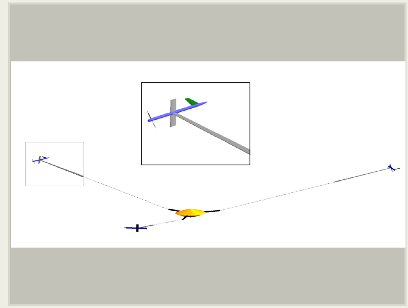
An investigation into a new mission concept approach to achieve unlimited high altitude long endurance flight to achieve geosynchronous atmospheric satellites for civil missions. The study will compare the new approach to existing approaches, with detailed analysis of the key differences that enable a reduction in structural weight by 50%, while also decreasing the drag by 50% through significantly higher aspect ratio wings, higher wing loading, and lower payload drag.

Anticipated Benefits

Achieving eternal flight opens the doors to atmospheric satellites. Existing satellites have a great number of capabilities that enrich our lives; however, their distance from the surface of the earth precludes certain types of transmission capabilities. Once eternal flight is achieved, that vehicle can serve the same role as ordinary satellites, but its close proximity will allow for real time two way communications, like wireless broadband internet. And with active controls, atmospheric satellites would not be constrained to geosynchronous orbits, like our existing satellite technology.

Primary U.S. Work Locations and Key Partners





Concept Diagram

Table of Contents

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Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
National Institute of Aerospace	Supporting Organization	Academia	Hampton, Virginia
University of Virginia-Main Campus	Supporting Organization	Academia	Charlottesville, Virginia

Primary U.S. Work Locations
Virginia

Project Transitions

October 2013: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

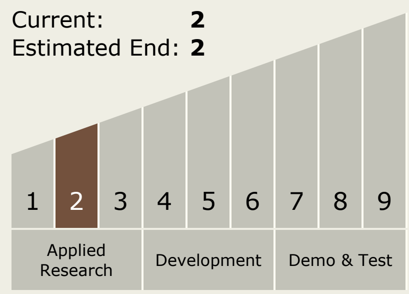
Eric A Eberly

Principal Investigator:

Mark A Moore

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **2**



June 2014: Closed out

Closeout Summary: The Centrifugally Sti ened Rotor (CSR) concept is a uniqu e con guration approach that has never previously been attempted, which could fundamentally lead to a new approach for High Altitude Long Endurance (HALE) or ATmospheric Satellite (ATSat) missions. AT-Sats map into many missions tha t existing GEO and LEO satellites simply can not perform, and in particular AT-S ats align with missions were communication transmission time needs to be mini mized for such capabilities as omni-present wireless broadband. The CSR signi c antly improved structural and aerodynamic e ciency open up the design space to become more feasible, with initial analysis indicating that feasibility may be poss ible through this concept approach in combination with energy storage of about 400 Whr/kg and thin- lm solar cells around 35%. Feasibility relates to accomplis hing year round missions at high U.S. latitudes. The Phase I research focused on developing analysis tools capable of capturing the unique attributes of this multi body approach, including aerodynamic, structural, force balance, and power req uired. Performance comparisons were made with other HALE tool sets used in th e analysis of DARPA Vulture concepts, as well as calibrations of the new tools to the most similar concepts. The initial performance analysis indicates a reduction in power required on the order of 35% compared to the prior QinetiQ Zephyr 7 HALE endurance record holder, with the Zephyr carrying less than a 5% payload fraction compared to the CSR concept with a 10% payload. A number of compell ing missions have been identifed that map directly into the unique capabilities of this advanced concept. Missions include: Multi-Functional Airborne Wind and Sur veillance Commercial Platforms at Lower Altitudes: Aerial platforms that operate at altitudes up to 2000 ft altitude (without FAA impediment of operational feasibi lity) that can both capture wind energy more e ectively than ground-based wind turbines, and provide close proximity surveillance/communications with a covera ge diameter of 50 miles. The CSR concept has the potential to achieve a higher Lift/Drag ratio compared to other airborne wind concepts, which results in highe r tether angles and less land area underneath the vehicle radius of operation tha t depends on incoming wind direction. O -shore application is particularly appeali ng since a CSR aerial vehicle would eliminate the need for a large/expensive mo oring platform, which is required for ground-based wind turbines. The ability of t his concept to have a non-moving tether from the ground to the center hub per mits the inertial connection to be less complex than current airborne wind turbin es. Potentially this mission concept could be applied all the way down to the leve l of distributed residential power production, with a sUAS sized version likely cap able of providing 2 to 5 kW of power at altitudes of 500 feet with average wind s peeds of less than 20 mph. Distributed Aperture AT-Sat Observatory: The CSR c oncept provides a large rotating structure, as well as large volume at the center hub, with the capability of operation above the majority of the atmosphere. Inte grating high resolution, compact, linked optic sensors (such as the Low Mass Pla nar Photonic Imaging Sensor currently being developed as Phase II NIAC resear ch) at the tip and root of each rotorwing will permit a rotating imaging array acr oss a full 600 diameter azimuth. Combining this with a lower resolution conventi onal imaging system in the center hub for image lling could provide a resolution never before possible. Such an observatory could be designed as a dual-purpose system that provides imaging both upwards for space investigations, as well as f or Earth imaging. Extra-Planetary Compact VTOL Exploration Platforms: A versio n of the CSR concept has been identified that enables full retraction of the rotor wing to achieve a highly compact VTOL vehicle that can operate at extremely lo w discloading (<0.03 lb/ft2) on atmospheres such as Mars that have atmospheri c densities similar to Earth at 100,000 feet altitude. Because it was highly uncert

Technology Areas

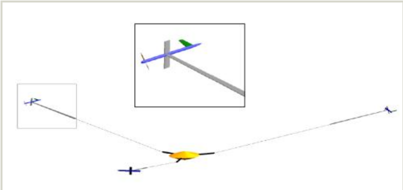
Primary:

- TX09 Entry, Descent, and Landing
  - └ TX09.2 Descent
    - └ TX09.2.1 Aerodynamic Decelerators

Target Destination

Earth

Images



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Concept Diagram
(https://techport.nasa.gov/image/102207)